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# Management of Supracondylar Humeral Fractures in Children

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## Abstract

Supracondylar humeral fractures are the most common elbow fractures in children and represent 3 % of all paediatric fractures. The most common cause is a fall onto an outstretched hand with the elbow in extension, resulting in an extension-type fracture (97–99 % of cases). Currently, the Gartland classification is used, which has treatment implications. Diagnosis is based on plain radiographs, but accurate imaging could be limited due to patient pain. Based on fracture type, the definitive treatment could be either non-operative (type I) or operative (type III/IV); however, when handling type II fractures controversy remains. Neither pin configuration have shown higher efficacy over the other. Complications are ~1 %, the most common being pin migration, with compartment syndrome as the most devastating. Overall, functional outcomes are good, and physical therapy does not appear to be necessary. The aim of the review was to develop an insight for the understanding of variations in presentation and management of supracondylar fracture of the humerus and the flowing trend in addition to the recent advances to deal with this particular pediatric orthopaedic entity which often presents as an emergency.

**Keywords:** Supracondylar Humeral Fractures, children, Dorgan technique.

**Mini review article** **Corresponding Author*, e-mail: *Ahmedabdelrazek25252525@gmail.com*

## 1. Introduction

In the evaluation and treatment of supracondylar fracture of the humerus, an adequate history and careful initial clinical examination are imperative. As part of the history it is often helpful to elicit the mechanism of the injury. The clinical examination reveals the well-known fracture symptoms, pain, swelling, abnormal position and function. The function of the radial nerve, ulnar nerve, and median nerve are established as well as pulsation of the radial artery. If there is suspicion of vascular damage, then a Doppler or an angiography are advisable. X-ray examination in two planes are necessary: on AP, and lateral views. X-ray diagnosis in fractures of type I may be problematic and comparative X-rays of the healthy side can be helpful in such cases [1]. All suspected extension type supracondylar fractures of the humerus should be splinted in 20º-30º of elbow flexion, which is usually the most comfortable position and places the least tension on vital neurovascular structures. Once the initial assessment and diagnostic evaluation are performed, the treatment method depends on the degree and direction of displacement [2]. Current methods of treatment of supracondylar fracture is based upon the Gartland classification [3]. Primary goals of treatment of displaced supracondylar fracture of humerus (Gartland type II and III) in children are to: (1) Achive stable reduction. (2) Prevent nerve injury and vascular compromise leading to compartment syndrome. (3) In long term to reduce cubitus varus the deformity [4].

## 2. Treatment decision

The reasons for subclassifying the three fracture types are to encourage the treating surgeon to look more critically at the radiographs and treat more vigorously those with a greater potential to develop a malunion even with "minimal " displacement (types I and II), and to deal very carefully with those having a greater potential for neurovascular compromise [5]. The truly un displaced type I fracture does not need treatment surgical in terms of reduction but just protection against re-injury. Type I might remodel satisfactory if untreated surgically, but some of these may worsen during immobilization and become more like type II and end up with malunion. Appropriate immobilization would minimize these complications. Types II should have a closed reduction, preferably under anesthesia with image intensifier assessment of position and stability and the effect of pronation and supination. Some type II fractures may need pinning. Types III fractures all need reduction, some closed with pinning and others possibly open with pinning. Because of the greater potential for soft tissue interposition with type III fractures, the indication for open reduction with these fractures is greater [5]. There has been no uniformity of opinion concerning the ideal method of the treatment of supracondylar fractures. Supracondylar fracture of the humerus is a condition that needs a most important skill that the orthopaedic surgeon must develop. Namely the ability to choose from a number of treatment modalities the best treatment for a given condition in a given patient [6].

### *2.1. Treatment modalities recommended include*

- Closed reduction and long arm cast or slab application.
- Closed reduction and percutaneous pinning by crossed Kirchner wires fixation or two lateral parallel, two lateral crossing or two lateral divergent wires, The Dorgan's percutaneous lateral cross-wiring.
- Open reduction and internal fixation with crossed Kirchner wires [4].

### *2.2. The closed reduction and percutaneous pinning*

Percutaneous pinning techniques have described by several authors and have become treatment of choice for maintaining closed reduction of displaced supracondylar fractures humerus in children. Viability of interaoperative image made percutaneous pinning. Development of image intensifiers and power pin drivers has made percutaneous pin fixation of supracondylar humerus fractures a relatively simple procedure. This technique should be considered with most unstable fracture circumstances, such as in:

- Transverse fracture line.
- Widely displaced fracture (more soft tissue disruption).
- Medial column impaction or commination [7].

### *2.3. The advantages of this technique are*

It provides stability, vascular safety, simplified management, reduced hospital stay, and consistently satisfactory appearance and function of the elbow [8]. It also allows direct assessment of the carrying angle in the extended elbow after stabilization of fracture with percutaneous pin. Less chances of elbow stiffness and less incidence of wound infection and decrease risk of ulnar nerve injury and reduce risk of rotational torque. It resolves dilemma of preserving the vascular function in fractures that are unstable at less than the acutely flexed position. Therefore the danger of Volkmann's ischemia is lessened since splinting in acute flexion is not necessary. Management of any associated forearm fractures is easier after the elbow is fixed [9]. Number of pins and the optimal position of pins have controversial issues.

### *2.4. One pin only*

Danielsson and Pettersson found that loss of reduction is common when only one pin was used. So it is not commonly used [10].

### *2.5. Two crossing pins (one medial and one lateral)*

Flynn et al, have advised using two pins, medial and lateral pins through medial and lateral epicondyles respectively [11]. the ulnar nerve is always a concern with the insertion of medial pin. Incidence of reported iatrogenic ulnar nerve injury ranges from 2 to 8% Lyons et al reviewed their own experience and that of published literature on this issue and concluded that majority of injuries related to medial Kirschner wire placement in cross wiring technique [12].

### *2.6. Dorgan technique (lateral cross k wires fixation)*

Two parallel K-wires may mounted through lateral cortex as an alternate method of fastening in order to prevent ulnar nerve injury. Ulnar nerve covered from putting medial K-wire. This configuration however is known to be less robust biomechanically than crosswire setup [13]. A modified variant of cross-wire technique, crossed lateral pin fixation with ascending and descending K-wires (Dorgan's side cross wiring), to achieve stability and prevent ulnar nerve injury. It proposed to achieve the cross-wire fixation on the lateral side only [14]. Dorgan's lateral cross k wire fixation technique is in use since 1994. It not only avoids ulnar nerve injury but biomechanically found to reduce the rotation torque by 37% as compared to medial and lateral cross k wire fixation [15].

### *2.7. Pearls*

- Anterior interosseous nerve palsy is more common in extension-type, while ulnar nerve palsy is more common in flexion-type supracondylar humerus fractures.
- The proximal humeral fragment may be driven anteriorly and distally into the nerve and also may be associated with laceration of the brachial artery. Having a high index of suspicion will avoid a delayed diagnosis of a vascular injury or a compartment syndrome in the face of a presumed neuropraxia.
- Appropriately positioning the image intensifier to allow for a true lateral will be beneficial when dealing with a highly unstable fracture in which rotating at the shoulder displaces the reduction.
-While holding initial traction, a "milking" maneuver over the distal humerus may release soft tissue brachialis muscle from the fragment and mobilize the displaced fragment.
- With hyperflexion, the fragment may displace into valgus and therefore may require a varus force applied during the flexion reduction maneuver.
- Placing the first pin through the capitellum will help obtain an ideal angle for bicortical fixation through medial column.
- Some amount of rotational malalignment is well tolerated.
- If, after pins are placed, the fracture remains malreduced, backing up the pins to remain in the distal fragment is useful when revising the reduction [3].

### *2.8. Pitfalls*

- Putting the patient's head next to the arm board of the table and then securing it, because the traction may put the head at risk of being pulled off from the bed.
- Avoid repeat manipulations as this may further exacerbate the swelling.
- Three poorly placed pins can still lose fixation.
- Ensure radial pulse is palpated after the reduction and fixation; a previously intact pulse may be lost if the artery becomes entrapped during the reduction [3].

## 3. Complications

- Vascular injury: It occurs to varying degrees in up to 20% of patients with a displaced supracondylar humerus fracture. Up to a third of patients may present with a decreased or absent radial pulse; however, the hand appears to be well perfused due to the extensive collateral circulation around the elbow. In this case, an urgent, not emergent, reduction is necessary. If there is concern regarding the perfusion of the distal extremity, recommend emergent reduction in the operating room prior to vascular studies as this usually restores blood flow to the hand. However, if perfusion remains inadequate after reduction, an immediate consultation with the vascular service should occur; an exploration of the antecubital fossa may be necessary [16].
- Neurologic injury: Supracondylar fractures of the pediatric humerus may be associated with a 10% to 19% incidence of nerve injury, most neurologic deficits (86%–100%) are neurapraxias and spontaneously recover within 2 to 6 months. The posteromedial displacement of a fragment is more likely

to result in neurologic compromise. The radial nerve particularly with posteromedial displacements, the median nerve with poster lateral displacements, or the anterior interosseous nerve (AIN) may be involved. Therefore recommended treatment involves observation for 6 months followed by nerve conduction studies if unrecovered to facilitate a decision about management [17].

- Compartment syndrome: The rate of compartment syndrome following closed reduction percutaneous pinning (CRPP) for supracondylar fracture of the humerus is 0.1-0.3%. When compartment syndrome is identified, an immediate forearm fasciotomy is required. If the diagnosis or fasciotomy are delayed, the patient will develop a Volkmann's ischemic contracture of the forearm.
- Malunion: Incidence of malunion has significantly improved with pin fixation. Cubitus varus or cubitus valgus may be cosmetically, rarely functionally, problematic to the patient. An osteotomy is necessary to correct this malunion.
- Pin site infection: Varying incidence of pin site infection, from <1% to 6.6%, have been reported. Infections typically resolve promptly with oral antibiotics with or without pin removal as indicated.
- Elbow stiffness: Children are usually resilient and will resolve this stiffness without formal physiotherapy. Physiotherapy may be necessary to improve overall range of motion [3].

**References**


[1] M. Varacallo, K.S. Mody, D. Parikh, M.J. Herman. (2018). Physical examination of the pediatric elbow. Pediatric Elbow Fractures: A Clinical Guide to Management. 13-21.

[2] J. Sawyer, D. Spence. (2021). Fractures and dislocations in children. Azar FM, Beaty JH. Campbell's Operative Orthopaedics. 14th ed. Philadelphia: Elsevier. 1502-1509.

[3] R. Omid, P.D. Choi, D.L. Skaggs. (2008). Supracondylar humeral fractures in children. JBJS. 90(5): 1121-1132.

[4] J. Herring, E. Tachdjian's Pediatric Orthopaedics, Book: From the Texas Scottish Rite Hospital for Children. In Elsevier Health Sciences: 2013.

[5] A. Hadlow, P. Devane, R. Nicol. (1996). A selective treatment approach to supracondylar fracture of the humerus in children. Journal of Pediatric Orthopaedics. 16(1): 104-106.

[6] A. Khairy. (2016). Fixation of supracondylar humeral fracture in children by medial and lateral pinning versus lateral pinning. MOJ Orthop Rheumatol. 6(7): 00248.

[7] R.T. Morrissy, S.L. Weinstein. (2006). Atlas of pediatric orthopaedic surgery. Lippincott Williams & Wilkins.

[8] M.S. Kocher, J.R. Kasser, P.M. Waters, D. Bae, B.D. Snyder, M.T. Hresko, D. Hedequist, L. Karlin, Y.-J. Kim, M.M. Murray. (2007). Lateral entry compared with medial and lateral entry pin fixation for completely displaced supracondylar humeral fractures in children: a randomized clinical trial. JBJS. 89(4): 706-712.

[9] C.C. Hasler. (2001). Supracondylar fractures of the humerus in children. European Journal of Trauma. 27: 1-15.

[10] L. Damelsson, H. Petterssox. (1980). Open reduction and pin fixation of severely displaced supracondylar fractures of the humerus in children. Acta Orthopaedica Scandinavica. 51(1-6): 249-255.

[11] I. Zaltz, P. Waters, J. Kasser. (1996). Ulnar nerve instability in children. Journal of Pediatric Orthopaedics. 16(5): 567-569.

[12] K. Memisoglu, C. Cevdet Kesemenli, H. Atmaca. (2011). Does the technique of lateral cross-wiring (Dorgan's technique) reduce iatrogenic ulnar nerve injury? International orthopaedics. 35: 375-378.

[13] R.K. Biradar, S.A. Khan. (2016). Study of type-III supracondylar humerus fractures in children treated by closed reduction with percutaneous crossed pin fixation. Al Ameen J Med Sci. 9(4): 241-7.

[14] A.S. Rizk, M.I. Kandil. (2018). Conventional versus lateral cross-pinning (Dorgan's technique) for fixation of displaced pediatric supracondylar humeral fractures: a randomized comparative study. The Egyptian Orthopaedic Journal. 53(4): 348-358.

[15] F.J. Shannon, P. Mohan, J. Chacko, L.G. D'Souza. (2004). "Dorgan's" percutaneous lateral cross-wiring of supracondylar fractures of the humerus in children. Journal of Pediatric Orthopaedics. 24(4): 376-379.

[16] J. Wu, A.D. Perron, M.D. Miller, S.M. Powell, W.J. Brady. (2002). Orthopedic pitfalls in the ED: pediatric supracondylar humerus fractures. The American journal of emergency medicine. 20(6): 544-550.

[17] J.E. Adams, S.P. Steinmann. (2006). Nerve injuries about the elbow. The Journal of Hand Surgery. 31(2): 303-313.